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| APPLICATION NO.   | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|-------------|----------------------|---------------------|------------------|
| 10/045,542  | 10/26/2001  | Mrinal Kanti Das     | 5308-157IP2         | 3570             |
| 20792   | 7590        | 03/02/2004           | EXAMINER            |                  |
| MYERS BIGEL SIBLEY & SAJOVEC<br>PO BOX 37428<br>RALEIGH, NC 27627 |             |                      | BARR, MICHAEL E     |                  |
|   |             | ART UNIT             | PAPER NUMBER        |                  |
|   |             |                      | 1762                |                  |

DATE MAILED: 03/02/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

| <b>Office Action Summary</b> | <b>Application No.</b> | <b>Applicant(s)</b> |
|------------------------------|------------------------|---------------------|
|                              | 10/045,542             | DAS ET AL.          |
| Examiner                     | Art Unit               |                     |
| Michael Barr                 | 1762                   |                     |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

1)  Responsive to communication(s) filed on 29 September 2003.

2a)  This action is **FINAL**.                            2b)  This action is non-final.

3)  Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## **Disposition of Claims**

4)  Claim(s) 1-20 is/are pending in the application.  
4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.

5)  Claim(s) 20 is/are allowed.

6)  Claim(s) 1-9, 11, 14, 18 and 19 is/are rejected.

7)  Claim(s) 10, 12, 13 and 15-17 is/are objected to.

8)  Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

9)  The specification is objected to by the Examiner.

10)  The drawing(s) filed on \_\_\_\_\_ is/are: a)  accepted or b)  objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)  The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)  Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a)  All    b)  Some \* c)  None of:  
1.  Certified copies of the priority documents have been received.  
2.  Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3.  Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1)  Notice of References Cited (PTO-892)  
2)  Notice of Draftsperson's Patent Drawing Review (PTO-948)  
3)  Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date 9.  
4)  Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_.  
5)  Notice of Informal Patent Application (PTO-152)  
6)  Other: \_\_\_\_.

**DETAILED ACTION**

***Continued Examination Under 37 CFR 1.114***

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after allowance or after an Office action under *Ex Parte Quayle*, 25 USPQ 74, 453 O.G. 213 (Comm'r Pat. 1935). Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, prosecution in this application has been reopened pursuant to 37 CFR 1.114. Applicant's submission filed on 9/29/2003 has been entered.

***Previously Allowable Subject Matter***

2. The indicated allowability of Claims 1-20 is withdrawn in view of the newly discovered reference(s) to Wang. Rejections based on the newly cited reference(s) follow.

***Claim Rejections - 35 USC § 102***

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

3. Claims 1, 4, 8-9, 11, 14, and 18-19 are rejected under 35 U.S.C. 102(b) as being anticipated by Wang.

Wang teaches providing a dielectric layer on a silicon carbide semiconductor substrate on a MOS or MOSFET device, by applying the dielectric layer to the silicon carbide, then annealing in a water vapor atmosphere at 950 °C for 30 minute, and then forming a metal electrode on the annealed layer, where the dielectric layer can be a silicon oxynitride layer (Col. 3, lines 41-67,

Col. 4, lines 42-56; Claims 1, 11). The water vapor atmosphere reads on the claimed hydrogen containing environment and the oxynitride layer reads on the claimed nitrided oxide layer.

\*\*\*\*Please note that the Wang reference is suitable under 35 USC 102(b) since the claimed invention does not have proper support in the applicant's provisional priority applications.

***Claim Rejections - 35 USC § 103***

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

6. Claims 2-3 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wang as applied to claim 1 above, and further in view of JP 2000-252461 by Arai et al. ("Arai").

Wang does not teach that the silicon carbide is a 4H polytype silicon carbide or that the silicon carbide is provided as a layer on a non-silicon carbide substrate. Arai is applied here for

the same reasons as given in paragraph 4 of the previous office action, No. 5. It would have been obvious to one skilled in the art to provide the silicon carbide of Wang as a 4H polytype silicon carbide and as a layer on a non-silicon carbide substrate, with the expectation of providing the desire MOS semiconductor devices, since it is shown by Arai that 4H polytype silicon carbide and that silicon carbide as a layer on a non-silicon carbide substrate is conventional and known forms and structures of silicon carbide used in MOS devices, as is the desired and use of Wang.

7. Claims 5-7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wang as applied to claim 1 above, and further in view of the article by Xu et al. ("Xu").

Wang does not teach the claimed method of forming the oxynitride layer. Wang is silent as to how to form the oxynitride layer. Therefore, it would have been obvious to one skilled in the art to use any conventional method of forming the oxynitride layer in Wang, with the expectation of providing the desired oxynitride layer in Wang. Xu is applied here for the same reasons as given in paragraph 4 of the previous office action, No. 5. Xu teaches making a MOS semiconductor device, wherein a silicon carbide layer is provided with an oxide layer on its surface, where a nitrided oxide layer is preferred over an oxide layer, since the nitrided layer improves the interface qualities of the oxide layer with the SiC, as opposed to the oxide layer alone, where the layer can be applied by forming an oxide layer and then nitriding/annealing with N<sub>2</sub>O, or by oxidizing in pure N<sub>2</sub>O and then further annealing (see Introduction and Experiments sections). It would have been an obvious modification to Wang to provide the nitrided oxide (oxynitride) layer on the SiC of the MOS semiconductor device in the manner taught by Xu, in order to improve the interface density with the SiC, as is taught by Xu and with the expectation of providing the desired oxynitride layer on the SiC of Wang, since Xu shows

that such a method is known and conventional in the art for providing an oxynitride layer on a SiC layer of a MOS device.

Wang and Xu do not teach annealing with hydrogen concurrently with the nitriding process. However, the performance of two steps simultaneously, which have previously been performed in sequence, is considered to be obvious (*In re Tatincloux* 108 USPQ 125). Therefore, it is the examiner's position that the performance of the hydrogen annealing and nitriding, in Wang and Xu, simultaneously would have been an obvious modification, with the expectation of providing the desired nitriding and annealing results.

***Allowable Subject Matter***

8. Claims 10, 12-13, and 15-17 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

9. Claim 20 is allowed.

10. The following is a statement of reasons for the indication of allowable subject matter: None of the prior art cited or reviewed by the examiner teaches or fairly suggests the claimed process where the annealing is performed at less than 900 °C, or performing subsequent step in a hydrogen environment (Claim 13), or the claimed annealing atmosphere of Claim 17.

***Conclusion***

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Michael Barr whose telephone number is 571-272-1414. The examiner can normally be reached on Monday-Thursday 6:00 am-3:30 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Shrive Beck can be reached on 571-272-1415. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Michael Barr  
Primary Examiner  
Art Unit 1762

MB  
February 24, 2004

